A4 concld

94. A communication station according to claim 78, wherein the processor element(s) develop a plurality of signal processing procedures commensurate with the plurality of antennae comprising the antenna array.

REMARKS

This amendment and response is submitted in response to an Office Action mailed November 29, 2001. With this response, Applicant has elected to cancel claims 1-39, without prejudice. Applicant offers herewith new claims 40-94. Applicant submits that support for such new claims can be found in the original specification, claims and/or figures. In this regard, no new matter has been introduced. In light of the foregoing amendments and the following remarks, Applicant respectfully requests reconsideration of the above-captioned application.

OBJECTION TO INFORMATION DISCLOSURE STATEMENT

In **paragraph 1** of the Action, a recently filed IDS was objected to under 37 CFR §1.98(a)(2) as failing to provide a copy of all cited references.

In response, Applicant apologizes for this oversight. Applicant is compiling a complete set of the cited references, and will provide such references to the Examiner as soon as possible.

OBJECTION TO THE SPECIFICATION

In **paragraph 2** of the Action, the disclosure was objected to for failing to fully cite a co-pending, incorporated by reference patent application.

In response, Applicant has amended the specification to provide proper reference to the cited, co-owned application.

Rejection and Objections to Claims 1-30

In **paragraphs 3-5** of the Action, select ones of claims 1-39 were rejected and/or objected to in light of various references. Without the need to further distinguish the cited references over claims 1-39, and without adopting the Examiner's characterization of such references or the strength of the rejections/objections based thereon, Applicant has amended the claims to cancel claims 1-39, without prejudice, rendering the rejection/objection to such claims moot. Applicant notes that such amendments were not made as a result of the cited references, but rather in an effort to prosecute a set of claims distinct from those that issued in the parent patent (USP 6,185,440).

NEW CLAIMS 40-94 IN VIEW OF CITED REFERENCES

As introduced above, the currently pending claims are now claims 40-94. Applicant notes that such claims are drawn to the same subject matter as the parent. Accordingly, Applicant respectfully asserts that no new search is required in the examination of such claims.

Without the need to further characterize the cited references, and without adopting the characterization put forth in the Action, Applicant respectfully submits that claims 40-94 are neither anticipated by, nor obvious in light of, the patents issued to Parish et al (USP 6,037,898), Sato et al (USP 5,745,858) and/or Dent (USP 5,708,971). More particularly, Applicant respectfully submits that none of the cited references disclose or suggest the claimed features of:

developing a plurality of signal processing procedures; and

> iterativelyprocessing a signal through each of the plurality of developed signal processing procedures to generate a plurality of processed signals which, when sequentially transmitted, generate a desired radiation level a number of location(s) within a desired sector

as provided, for example, in new claim 40. That is, none of the cited references disclose or suggest at least the claimed elements of developing a plurality of processing procedures iteratively applied to a signal through a sequential plurality of transmissions of the signal to generate plurality of processed signals which, when sequentially transmitted through an antenna array, generate a desired radiation level at a number of location(s) within a desired sector.

Because the claimed invention allows, *inter alia*, the benefit of enabling a near omni-directional radiation from a plurality of antennae comprising an antenna array, it is understandable that none of the cited references, which fail to even mention sequential transmission of the same signal utilizing multiple signal processing procedures, or generating an omni-directional radiation pattern, fail to teach or suggest at least one of the limitations recited in the claims. Insofar as the cited references fail to disclose or suggest that which is claimed in, for example, claim 40, Applicant respectfully submits that claim 40 is patentable over the cited references.

Applicant respectfully submits that such features are similarly claimed new claims 60 and 78, albeit in accordance with their respective embodiments. Accordingly, Applicant respectfully submits that such claims are likewise patentable over the cited references for arguments analogous to those associated with claim 40.

CONCLUSION

In light of the foregoing amendments and remarks, Applicant respectfully submits that claims 40-94 are in condition for allowance, and earnestly awaits notice thereof.

Please charge any shortages and credit any overcharges to our Deposit Account No. 02-2666.

Respectfully submitted,
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: February 27, 2002

Michael A. Proksch

Michael A. Proksch
Reg. No. 43,021

12400 Wilshire Boulevard
Seventh Floor
Los Angeles, CA 90025-1026
(503) 684-6200

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to Commissioner of Patents, Washington, D.C. 20231 on:

2.27.02
Date of Deposit

Derek Watson
Name of Person Mailing Correspondence

Signature 2.27.02
Date

Appendix A: Marked-up Version of Amendments

IN THE SPECIFICATION

• *On page 13, please amend the paragraph denoted by lines 2 through 23 as follows:*

The invention preferably is implemented in the base station part of a wireless communication system with SDMA, in particular a cellular SDMA system. In one implementation, the system operates using the PHS communications protocol which is suitable for low mobility applications. The subscriber units may be mobile. Above-mentioned and incorporated-herein-by-reference co-owned U.S. Patent Application 08/729,390 describes the hardware of a base station of such a system in detail, the base station preferably having four antenna elements. In a second implementation, the subscriber units have fixed location. The PHS communications protocol again is used. Wireless systems with fixed locations are sometimes called *wireless local loop* (WLL) systems. A WLL base station into which some aspects of the present invention are incorporated is described in co-owned U.S. Patent Application [09/xxx,xxx] 09/020,049 (filed February 6, 1998) entitled *POWER CONTROL WITH SIGNAL QUALITY ESTIMATION FOR SMART ANTENNA COMMUNICATION SYSTEMS*, Yun, Inventor, incorporated-herein-by-reference (hereinafter "Our Power Control Patent"). Such a WLL base station may have any number of antenna elements, and many of the simulations described herein will assume a 12-antenna array. It will be clear to those [or] of ordinary skill in the art that the invention may be implemented in any SDMA system with one or more that one spatial channel(s) per conventional channel, and having mobile, fixed or a combination of mobile and fixed subscriber units. Such system may be analog or digital, and may use frequency division multiple access (FDMA), code division multiple access (CDMA), or

time division multiple access (TDMA) techniques, the latter usually in combination with FDMA (TDMA/FDMA).

• *Please amend the paragraph from page 13, line 24 to page 14, line 22, as follows:*

Figure 1 shows the transmit processing part of the transmit RF part of a base station (BS) on which the present invention may be embodied. Digital downlink signal 103 is to be broadcast by the base station, and typically is generated in the base station. Signal 103 is processed by a signal processor 105 which processes downlink signal 103, the processing including spatial processing comprised of weighting the downlink signal 103 in phase and amplitude into a set of weighted downlink antenna signals, the weighting describable by a complex valued weight vector. Signal processor 105 may include a programmable processor in the form of one or more digital signal processor devices (DSPs) or one or more general purpose microprocessors (MPUs) or both one or more MPUs and one or more DSPs together with all the necessary memory and logic to operate. The reader is referred to above-mentioned co-owned U.S. Patent Applications 08/729,390 and [09/**xxx,xxx**] Our Power Control Patent for details. In the preferred embodiments, the spatial processing (spatial multiplexing) and the methods of the present invention are implemented in the form of programming instructions in a signal processor 105 that when loaded into memory and executed in the DSP(s) or MPU(s) or both cause the apparatus of Figure 1 to carry out the methods. Thus signal processor 105 has the same number of outputs, that number denoted by *m* herein, as there are antenna elements in the transmitting antenna array of the base station. The outputs are shown as 106.1, 106.2, ..., 106.*m* in Figure 1. In the preferred embodiment, the same antenna array is used for transmitting and for receiving with time domain duplexing (TDD) effected by transmit/receive switch. Since the invention mainly is

concerned with transmitting, duplexing functionality is not shown in Figure 1. Figure 1 thus would apply also for a base station that only transmits, for a base station with different antennas for transmission and reception, and for a base station that uses frequency domain duplexing (FDD) with the same transmit and receive antennas. The *m* outputs of the signal processor 105, typically but not necessarily in baseband, are upconverted to the required RF frequency, then RF amplified and fed to each of the *m* antenna elements 109.1, 109.2, ..., 109.*m*. In the WLL and mobile systems on which the invention is implemented, some of the upconversion is carred out digitially, and some in analog. Since upconversion and RF amplification is well known in the art, both are shown combined in Figure 1 as RF units 107.1, 107.2, ..., 107.*m*.

• *Please amend the paragraph denoted by page 15, line 22 through page 16, line 25 as follows:*

In another implementation, the signal processing procedure includes post-processing after the spatial processing, for example, using analog or digital filtering in baseband, or analog filtering in the RF domain, the spatial processing typically but not necessarily using essentially the same transmit weight vector for each repetition. In each of the *n* instances of transmitting the downlink signal, the downlink signal is spatially processed to a plurality of signals, one for each antenna element. Each of the antenna signals is post-processed in a different way. Note that each of the antenna signals is upconverted to RF, usually with one or more stages of intermediate frequency (IF) amplification, and the processing may be done before such up-conversion, using digital or analog means, or after digital upconversion (when there is digital upconversion) using digital or analog means, or after analog upconversion using analog means. In the analog implementation, different analog filtering is introduced in each of the *m* antenna signals, and in each of the *n* instances in RF units 107.1, 107.2, ..., 107.*m* feeding the *m* antenna elements

109.1, 109.2, ..., 109.*m*. This may be done, for example, by itnroducign a different amount of time delay in each of the *m* antenna signals, and in each of the *n* instances. Figure 2 shows post processing means 203.1, 203.2, ..., 203.*m* which, for example, are each time delay apparatuses which produce *m* different time delays. For each RF unit, the post processing means is seen at the input. However, it would be clear to those in the art that post-processing might occur within the RF unit, and not only in baseband. When such time delays are introduced, appropriate equalizers may be needed by receiving subscriber units, as would be clear to those of ordinary skill in the art. The post processing may be done also, for example, by introducing a different amount of frequency offset in each of the *m* antenna signals, an in each of the *n* instances. Figure 2 shows post-processing means 203.1, 203.2, ..., 203.*m* which in this case are each frequency offset apparatuses which produce *m* different frequency offsets. The amounts of different frequency offset or different time delay to introduce in each of the *m* antenna signals would be insufficient to cause problems for the demodulators at the subscriber units but sufficient to orthogonalize the *m* antenna signals. A particular frequency-offset introducing post processing embodiment may be used in systems that use programmable upconverter/filters in the RF transmit apparatuses. Such a device is the Graychip, Inc. (Palo Alto, California) GC4114 quad digital upconverter/filter device which is used in the implementation of RF systems 107.1, 107.2, ..., 107.*m* in the base station of the WLL system described in Our Power Control Patent[, (above-mentioned U.S. Patent application 09/**xxx,xxx**)]. The GC4114 has phase offset (and gain) registers which may be used to introduce frequency offset into the signal.

IN THE CLAIMS

Please cancel claims 1-39, without prejudice.

Please add the following new claims 40-94.

40. A method comprising:

developing a plurality of signal processing procedures; and

iteratively processing a signal through each of the plurality of developed signal processing procedures to generate a plurality of processed signals which, when sequentially transmitted through a coupled antenna array, generate a desired radiation level at a number of locations within a desired sector.

41. A method according to claim 40, further comprising:

sequentially transmitting each of the generated plurality of processed signals to achieve the desired radiation level at a number of locations in the desired sector during at least one of said sequential transmissions.

42. A method according to claim 40, wherein the desirable radiation level is a non-null level.

43. A method according to claim 40, wherein the desired sector is comprised of a range of azimuths up to the complete range of azimuths of the antenna array.

44. A method according to claim 40, wherein developing a signal processing procedure comprises:

selecting a weight vector from a sequence of different weight vectors, wherein elements of the weight vectors selectively modify one or more characteristics of transmission of the signal from each antenna in the antenna array.

45. A method according to claim 44, wherein the transmission characteristics include one or more of signal amplitude and/or phase.

46. A method according to claim 45, wherein the sequence of weight vectors share an amplitude value and have random phase values.

47. A method according to claim 45, wherein the sequence of weight vectors is comprised of weight vectors that are orthogonal.

48. A method according to claim 47, wherein the orthogonal weight vectors have elements with the same magnitude.

49. A method according to claim 47, wherein the orthogonal weight vectors are developed from one or more of rows or columns of a complex valued Walsh-Hadamard matrix, rows or columns of a real valued Hadamard matrix, and/or a sequence whose elements are basis vectors of a Fourier transform.

50. A method according to claim 45, wherein the sequence of weight vectors is comprised of weight vectors designed to provide a desirable radiation pattern within at least a sub-sector of an overall desired sector.

51. A method according to claim 50, wherein the desirable radiation pattern is a near omni-directional radiation pattern.

52. A method according to claim 50, wherein the overall desired sector is the whole range in azimuth.

53. A method according to claim 45, wherein the sequence of weight vectors includes weight vectors that are representative of weight vectors designed for transmission to known subscriber unit(s).

54. A method according to claim 53, wherein the weight vectors designed for transmission to known subscriber unit(s) are determined from spatial signature(s) associated with each of the subscriber unit(s).

55. A method according to claim 45, wherein the weight vectors are determined from weight vectors designed for transmission to known subscriber unit(s) using a vector quantization clustering process.

56. A method according to claim 55, the vector quantization clustering process comprising:

assigning an initial set of weight vectors as a current set of representative weight vectors;

combining each designed for subscriber unit weight vector with its nearest representative weight vector in the current set, according to some association criterion;

determining an average measure of a distance between each representative weight vector in the current set and all weight vectors combined with that representative weight vector;

replacing each representative weight vector in the current set with a core weight vector for all the weight vectors that have been combined with that representative weight vector; and

iterative repeating the combining, determining and replacing steps until a magnitude of the difference between the average measure in a present iteration and the average distance in the previous iteration is less than a threshold.

57. A method according to claim 40, wherein the plurality of signal processing procedures is commensurate with the plurality of antennae within the antenna array used to sequentially transmit the signal.

58. A storage medium comprising content which, when executed by an accessing machine, implements a method according to claim 40.

59. A wireless communication system element comprising:

a storage medium including content; and

a processor element, coupled with the storage medium, to execute at least a subset of the content to implement a method according to claim 40.

60. A subscriber unit comprising:

two or more antenna configured as an antenna array; and

processing element(s), coupled with the antenna array, to develop a plurality of signal processing procedures, and to iteratively process a signal through each of the plurality of developed signal processing procedures to generate a plurality of processed signals which, when sequentially transmitted via the antenna array, generate a desired radiation level at a number of locations within a desired sector.

61. A subscriber unit according to claim 60, wherein the processing element(s) are comprised of one or more of an application specific integrated circuit (ASIC), a digital signal processor (DSP), a field-programmable logic array (FPGA) and/or a microcontroller resident within the subscriber unit.

62. A subscriber unit according to claim 60, further comprising:

a transceiver, coupled with the antenna array and the processor element(s), to sequentially transmit each of the generated plurality of processed signals to achieve the desired radiation level at a number of locations in the desired sector during at least one of said sequential transmissions.

63. A subscriber unit according to claim 62, wherein the processor element(s) are integrated within the transceiver.

64. A subscriber unit according to claim 63, wherein the transceiver comprises at least one processor element for each antenna within the antenna array.

65. A subscriber unit according to claim 60, wherein the processor element(s) select a radiation level that is a non-null level.

66. A subscriber unit according to claim 60, wherein the desired sector is comprised of a range of azimuths up to a complete range of azimuths of the antenna array.

67. A subscriber unit according to claim 66, wherein the processor element(s) select a weight vector from a sequence of different weight vectors to develop the processing procedure, wherein elements of the weight vectors selectively modify one or more characteristics of transmission of the signal from each antenna in the antenna array.

68. A subscriber unit according to claim 67, wherein the transmission characteristics include one or more of a signal amplitude and/or phase.

69. A subscriber unit according to claim 67, wherein the sequence of weight vectors share an amplitude value and have random phase values.

70. A subscriber unit according to claim 67, wherein the sequence of weight vectors are comprised of weight vectors which are orthogonal to one another.

71. A subscriber unit according to claim 70, wherein the orthogonal weight vectors share a common magnitude.

72. A subscriber unit according to claim 70, wherein the processor element(s) develop the orthogonal weight vectors from one or more of rows or columns of a complex valued Walsh-Hadamard matrix, rows or columns of a real valued Hadamard matrix, and/or a sequence whose elements are basis vectors of a Fourier transform.

73. A subscriber unit according to claim 67, wherein the sequence of weight vectors is comprised of weight vectors designed to provide a desirable radiation pattern within at least a sub-sector of an overall desired sector.

74. A subscriber unit according to claim 73, wherein the processor element(s) develop the sequence of weight vectors designed to provide a desirable radiation pattern based, at least in part, on information associated with known communication station(s) in the desired sector.

75. A subscriber unit according to claim 74, wherein the processor elements develop the sequence of weight vectors from spatial signature(s) associated with the known communication station(s).

76. A subscriber unit according to claim 74, wherein the processor element(s) develop the sequence of weight vectors using a vector quantization clustering process.

77. A subscriber unit according to claim 70, wherein the processor element(s) develop a plurality of signal processing procedures commensurate with the plurality of antennae comprising the antenna array.

78. A communication station comprising:

two or more antenna configured as an antenna array; and

processing element(s), coupled with the antenna array, to develop a plurality of signal processing procedures, and to iteratively process a signal through each of the plurality of developed signal processing procedures to generate a plurality of processed signals which, when sequentially transmitted via the antenna array, generate a desired radiation level at a number of locations within a desired sector.

79. A communication station according to claim 78, wherein the processing element(s) are comprised of one or more of an application specific integrated circuit (ASIC), a digital signal processor (DSP), a field-programmable logic array (FPGA) and/or a microcontroller resident within the communication station.

80. A communication station according to claim 78, further comprising:

one or more transceivers, coupled with the antenna array and the processor element(s), to sequentially transmit each of the generated plurality of processed signals to achieve the desired radiation level at a number of locations in the desired sector during at least one of said sequential transmissions.

81. A communication station according to claim 80, wherein the processor element(s) are integrated within one or more of the transceiver(s).

82. A communication station according to claim 80, wherein the transceiver comprises at least one processor element for each antenna within the antenna array.

83. A communication station according to claim 78, wherein the desired sector is comprised of a range of azimuths up to a complete range of azimuths of the antenna array.

84. A communication station according to claim 78, wherein the processor element(s) select a weight vector from a sequence of different weight vectors to develop the processing procedure, wherein elements of the weight vectors selectively modify one or more characteristics of transmission of the signal from each antenna in the antenna array.

85. A communication station according to claim 84, wherein the transmission characteristics include one or more of a signal amplitude and/or phase.

86. A communication station according to claim 84, wherein the sequence of weight vectors share an amplitude value and have random phase values.

87. A communication station according to claim 84, wherein the sequence of weight vectors are comprised of weight vectors which are orthogonal to one another.

88. A communication station according to claim 87, wherein the processor element(s) develop the orthogonal weight vectors from one or more of rows or columns of a complex valued

Walsh-Hadamard matrix, rows or columns of a real valued Hadamard matrix, and/or a sequence whose elements are basis vectors of a Fourier transform.

89. A communication station according to claim 84, wherein the sequence of weight vectors is comprised of weight vectors designed to provide a desirable radiation pattern within at least a sub-sector of an overall desired sector.

90. A communication station according to claim 89, wherein the processor element(s) develop the sequence of weight vectors designed to provide a desirable radiation pattern based, at least in part, on information associated with known subscriber unit(s) in the desired sector.

91. A communication station according to claim 90, wherein the processor elements develop the sequence of weight vectors from spatial signature(s) associated with the known subscriber unit(s).

92. A communication station according to claim 90, wherein the processor element(s) develop the sequence of weight vectors using a vector quantization clustering process.

93. A communication station according to claim 92, wherein performing the vector quantization cluster process, the processor element(s):

assign an initial set of weight vectors as a current set of representative weight vectors;

combine each designed for subscriber unit weight vector with its nearest representative weight vector in the current set, according to some association criterion;

determine an average measure of a distance between each representative weight vector in the current set and all weight vectors combined with that representative weight vector;

replace each representative weight vector in the current set with a core weight vector for all the weight vectors that have been combined with that representative weight vector; and

iteratively repeat the combining, determining and replacing elements until a magnitude of the difference between the average measure in a present iteration and the average distance in the previous iteration is less than a threshold.

94. A communication station according to claim 78, wherein the processor element(s) develop a plurality of signal processing procedures commensurate with the plurality of antennae comprising the antenna array.